SPHEROMATIC H

Spherometer

Precision instrument for measuring radii of curves in both convex and concave spherical surfaces such as lenses, test glass pairs, mirrors etc.

OPERATION MANUAL

Version 01.1/01-99/ENG

Operation manual

The information contained in this manual can be modified without prior notice. In spite of conscientious preparation, it is possible that this manual contains errors or incompletions. No liability is accepted for damages encruing thereof.

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HOFBAUER · Optik, Mess- und Prüftechnik

Pippinger Straße 47 d D-81245 Munich
Telefon (089) 89 66 90 88 Fax (089) 89 66 90 89

1 Important Information

1.1 Repair

Equipment shall be modified or serviced only by persons authorised by the firm HOFBAUER.
In case of repair only original components of the firm HOFBAUER are to be used.
Following any repairs or technical modifications, the device must be readjusted according to our technical specifications.
In case of any technical questions, components should always be referred to by their component numbers.

1.2 Liability for Function or Defect

The warranty is void if the equipment is modified or serviced by persons not authorised by the firm HOFBAUER, or improperly maintained or handled.

1.3 Accessories

Only original components and spherometer rings tested and calibrated by the firm HOFBAUER may be used.

1.4 Safety Notes

This device must only be operated in accordance with this Operation Manual and for the purpose described herein.
The year of the production and serial number of the device can be found on the bottom panel of the device.
Operation Manual should be retained for future use.

2 Use of the Spherometer

The Spherometer is a precision instrument with a digital counter and appropriate software for the precise measurement of the radii of curves in both convex and concave spherical surfaces such as lenses, test glass pairs, mirrors, etc.

3 Safety Notes and Precautions

Care should be taken when extending the length gauge plunger!
Avoid improper contact of the length gauge plunger.
It is the responsibility of the user to operate the device so as to avoid accidents and to be knowledgeable of the laws concerning the operation of electrical devices.
The device should not be operated in hazardous locations.

4 Description of the Device

4.1 Basic Principle

Measurement of the rise h is accomplished by means of mechanical touching of the measurement and reference area with the aid of an incremental high-precision linear measuring system.

Determining the radius length is based on the calculation of the known value **r** (the Spherometer ring radius), the length of the rise **h** and in the case of the spherometer ball rings, the radius of the contact ball **k**.

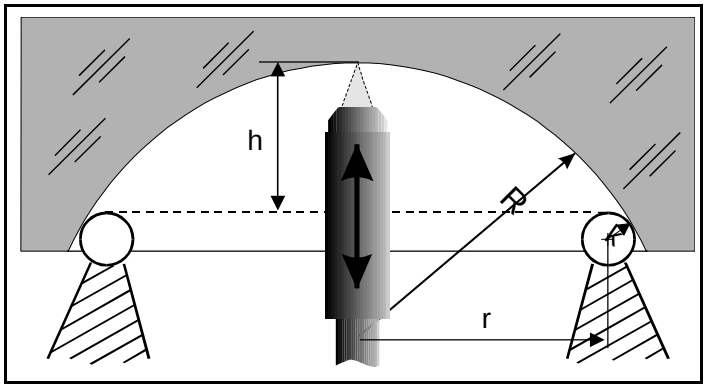

Fig. 4.1: Spherometer Principle of Operation

For a concave test object the positive value of the radien of the contact balls is used (+K); for a convex test object, the negative value (-K).

For the spherometer ring with 3-point-ball support the following fomula is used:

$$R = \frac{r^2}{2h} + \frac{h}{2} \pm K$$

For the closed spherometer sharp edge rings with edge support:

$$R = \frac{r^2}{2h} + \frac{h}{2}$$

Where there are 2 spherometer ring radien ($r_{inside\ edge}$ and $r_{outside\ edge}$).

4.2 Design

The complete measuring system consists of:

1. Spherometer
2. Set of the Spherometer Rings
3. Motor Control Unit
4. Counter
5. PC
6. Software

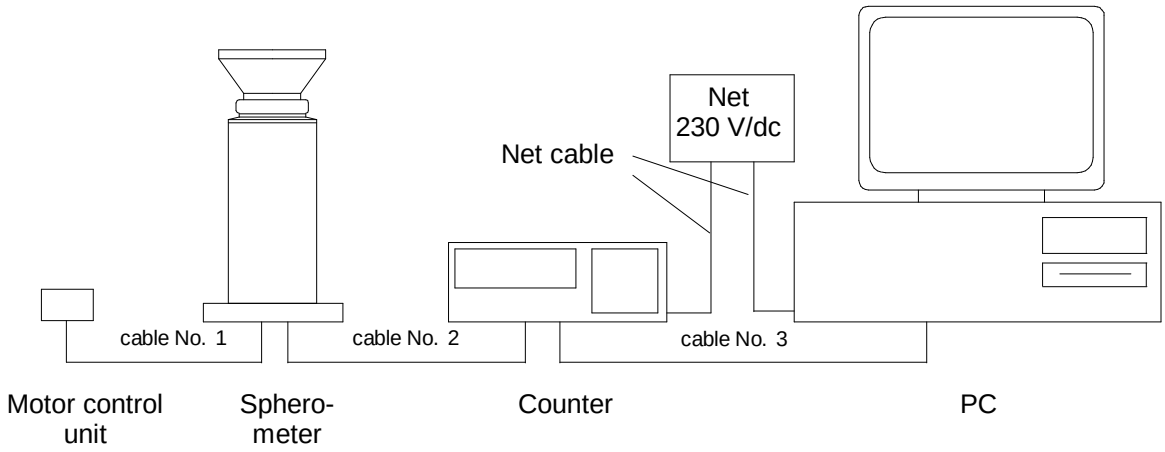

Fig. 4.2.1: Components of the measuring system

1. Spherometer

Within the Spherometer's tube is an incremental digital length gauge with ball-point measuring contact MT 60 which is exactly centric adjusted by means of the centre disc. Spherometer rings must be carefully placed on the support and/or reference surface (Fig. 4.2.2) of the centre disc with a clearance fit.

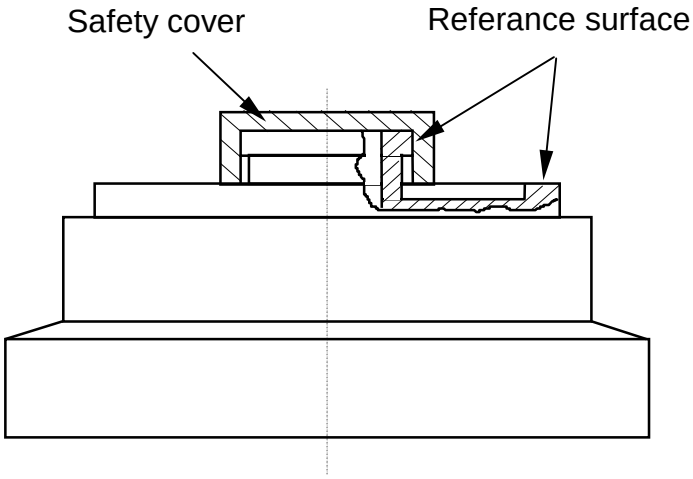

Fig. 4.2.2: Referance surface of the spherometer

2. Spherometer Rings Set:

A standard set of the spherometer rings consists of 8 spherometer rings with a diameter from 8 to 120 mm. The related calibration data such as diameter, measuring accuracy, etc. are included in the SPHEROWIN-software and must not be changed.

Sphero-meter ring	Diameter , mm	Identification number
A	8	23731101
B	15	23731102
C	25	23731103
D	35	23731104
E	50	23731105
F	65	23731106
G	80	23731107
H	120	23731108

Fig. 4.2.1: Spherometer Rings Set

3. Motor Control Unit:

The motor control unit is connected with the spherometer by a 4-pole cable No. 1. The motorical length gauge can be moved in 2 different directions by two push buttons **1** and **2** (Fig. 4.2.3).
Gauging pressure should be adjusted to level 3 (motor power approx. 0.75 N) by means of the step-switch **3** (Fig. 4.2.3).

Fig. 4.2.3: Motor control device

1. Push button ”OFF” RETRACTION
2. Push button ”ON” EXTENSION
3. Switch of the gauging pressure
4. Flange socket for the 4-pole cable No. 1

4. Counter:

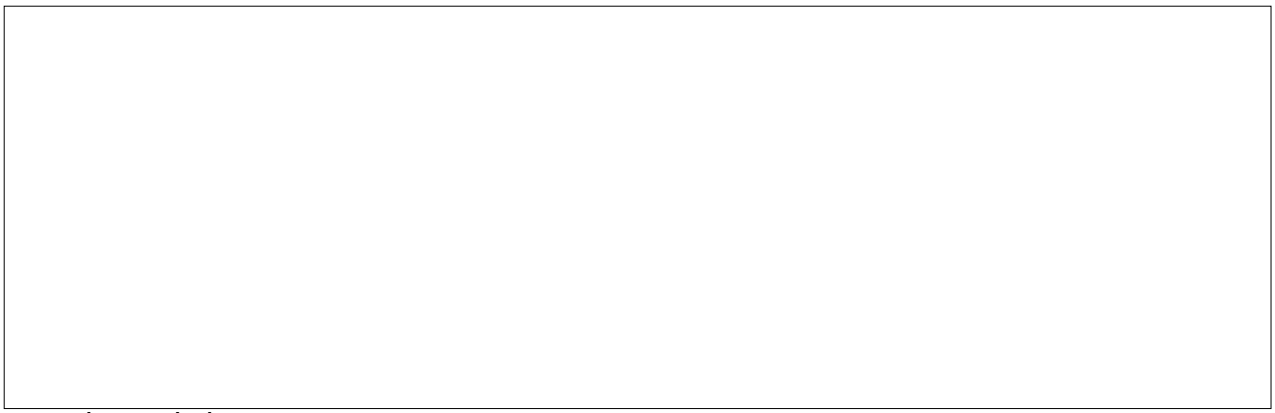

Fig. 4.2.4: Counter (Rear panel)

5. Mains switch
6. Mains socket or cable input
7. Flange socket for the cable No. 2
8. Flange socket for the cable No. 3 (Data interface V.24/RS-232-C)

5. PC:

IBM-compatible PC with following minimum requirements:
80386- processor; DOS 5.0; Windows 3.1.

6. Software:

User-oriented Windows software providing statistical evaluations, protocol documentation and storage of measurement settings.

4.3 Installation and Starting of the Operation

4.3.1 List of Delivered Equipment

1. Spherometer - Basic Device No. SPH 060 02
2. Control Unit (HEIDENHEIN Motor Control Unit SG 60M)
3. Display Unit (HEIDENHEIN Counter ND 221)
4. 1 Net Cable
5. Operation Manual
6. 1 Diskette
7. 1 PC Connection Cable

4.3.2 Installation

1. Carefully unpack spherometer, counter, motor control unit and cables according to the specifications described in chapter 6.
2. Ensure that all the components are included (see List of the Delivered Equipment above).
3. Place spherometer and accessories on a flat horizontal surface.
4. Connect motor control unit (flange socket **4** (Fig. 4.2.3)) to spherometer using the 4-pole cable No. 1.
5. Set the gauging pressure switch **3** (Fig. 4.2.3) of the motor control unit at the position 3.
6. Connect counter (flange socket **7** (Fig. 4.2.4)) to spherometer with cable No. 2.
7. Connect counter (main socket **6** (Fig. 4.2.4)) to mains with the main cable observing correct voltage rating (100V to 230V (-15% to + 10%)/dc, frequency 48 Hz to 62 Hz).
8. **If using the SPHEROWIN-Software** connect the counter (flange socket **8** (Fig. 4.2.4)) to PC (serial interface) with cable No. 3.
9. Switch on the counter (main switch **5** (Fig. 4.2.4)).
10. Set the value "0" by pressing the "CL" button at the front panel of the counter.

4.3.3 Starting of the Operation

1. **If using the SPHEROWIN-Software** install this software according to chapter 5.1.
2. Select counter interface settings as follows:

0,1 µm display step,
600 baud data transfer rate,
‘even parity’ parity control,
2 Stopbits per data word,
Counting direction "negative" (see counter operation manual).
Note: These settings should already be set by delivery.

3. Retract length gauge plunger by pressing the "OFF" button!

4. Remove safety cover of the spherometer (Fig. 4.2.2).

4.4 Measurements

The length gauge plunger can be moved by the two push buttons of the motor control unit.
Prevent the lift off of the light lenses using appropriate weight (motor power approx. 0.75 N, level 3 of the switch of the control unit).
Use a ring with a biggest possible diameter to acquire the most accurate measurement.
Attention: a test object should only touch the three supporting balls of the spherometer ring!
Ensure that support and/or reference surfaces are clean before placing the spherometer rings.

4.4.1 Measurement procedures

1. Putting on spherometer ring:

Important: Before putting on the ring retract the length gauge plunger by pressing the "OFF" button of the control unit!

Select an appropriate spherometer ring.
Clean the reference surfaces of the spherometer ring with benzine.
Put spherometer ring carefully on the centre disc of the spherometer.

2. Putting on the component parts (test object, plane plate):

Ensure that plunger is retracted and spherometer ring is on.
Put component part on the spherometer ring with surface to be measured at the bottom.
Aplly light pressure stih the hand or other appropriate weight to avoid having light-weight parts lifting off.

3. Contact (mechanical touching):

Extend plunger by pressing the "ON" button of the control unit until it touches the surface to be measured. The point of contact can either be heard or determined by the value displayed on the counter, which becomes stabile.

4. Reading out of the measured values:

- manually: after contact of the measured surface note the measured value,
- automatically: Using SPHEROWIN-Software after contact of the measured surface (when the measured value has stabilised) click the "OK" button with the mouse or press the "ENTER" button of the keyboard. The value will be automatically read out by the program by means of the RS-232 interface.

5. Retraction of the plunger:

Retract plunger by pressing "OFF".

6. Removing of the component part:

Carefully remove component part after retracting of the plunger.

7. Reset:

To set the "0" value press the "0" button then the "ENTER" button of the control unit. **This is not required by when using SPHEROWIN-Software.**

4.4.2 Measurement of the radii

Using SPHEROWIN-Software, open the program as explained in chapter 5.2 and initialize the settings.
Start the measurement with a mouse-click on the "start measurement" button.
Follow the program instructions (chapter 5.2).

4.4.2.1 Measurement of the convex surface

1. Put on the plane plate.
2. Touch the reference surface of the plane plate.
3. Reset counter or read out measured value using the SPHEROWIN-software.
4. **Retract plunger.**
5. Put on test object (convex).
6. Touch the surface.
7. Read out the measured value.
8. **Retract plunger.**
9. Repeat the measurement cycle as required.

4.4.2.2 Measurement of the concave surface

1. Put on the plane plate.
2. Touch the reference surface of the plane plate.
3. Reset counter or read out measured value using the SPHEROWIN-software.
4. **Retract plunger.**
5. Put on test object (concave).
6. Touch the surface.
7. Read out the measured value.
8. **Retract plunger.**
9. Repeat the measurement cycle as required.

4.4.2.3 Measurement of test glass pairs plane-convex-concave

1. Put on the plane plate.
2. Touch the reference surface of the plane plate.
3. Reset counter or read out measured value using the SPHEROWIN-software.
4. **Retract plunger.**
5. Put on convex test object.
6. Touch the surface.
7. Read out the measured value.
8. **Retract plunger.**
9. Put on concave test object.
10. Touch the surface.
11. Read out the measured value.
12. **Retract plunger.**
13. Repeat the measurement cycle as required.

4.4.2.4 Measurement of test glass pairs convex-concave

Optional using the software module SPH WINP "Increased Accuracy of test glass pair measurement.

Using this option and minimising the systematic influence of the radii of the spherometer ring you can improve the absolute accuracy of the radii measurement by high precision test glasses pairs. The last chosen option of the menu setting "test glasses pair ” will be kept after the end and new start of the measurement.

1. Put on convex test object.
2. Touch the surface.
3. Read out the measured value.
4. **Retract plunger.**
5. Put on concave test object.
6. Touch the surface.
7. Read out the measured value.
8. **Retract plunger.**
9. Repeat the measurement cycle as required.

4.4.3 Completion

1. **Ensure that the plunger is retracted!**
2. Carefully remove the spherometer ring from the centre disc of the spherometer.
3. Grease the reference surfaces of the spherometer ring using acid-free vaseline.
4. Switch off the counter.
5. Carefully replace the safety cover on the centre disc of the spherometer.

5 Software-Installation and Software-description

5.1 Software-Installation

Create directory for your program, e.g. ‘C:\sphero’.
Important: path and file names may not be longer than 8 signs.

Copy the files

- sphaero.exe
- kalib.ini
- sph180**.ini
- grund.kon
- vbrun300.dll
- commdlg.dll
- cmdialog.vbx
- mscomm.vbx
- spin.vbx
- threed.vbx into this directory.

It is advisable to create subdirectories for:

o measurement setting files
o protocol files and
o statistical files.

In this way, data can be easily identified.

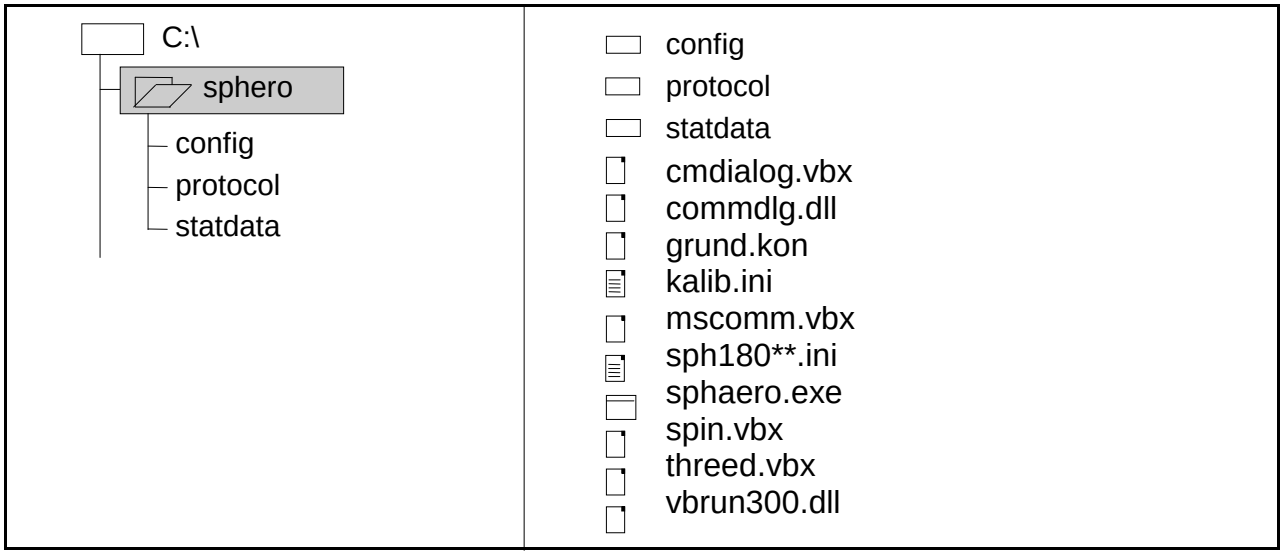

Abb. 5.1: advisable file structure for SPHEROWIN-software

Using Windows 3.1 check whether ‘share.exe’ is loaded in file ‘autoexec.bat’. If not, this command must be added.

5.2 Software-description

Start the program SPHEROWIN by executing the file ‘sphaero.exe’.
A menu is displayed in which all the settings can be initialized for the measuring procedure.

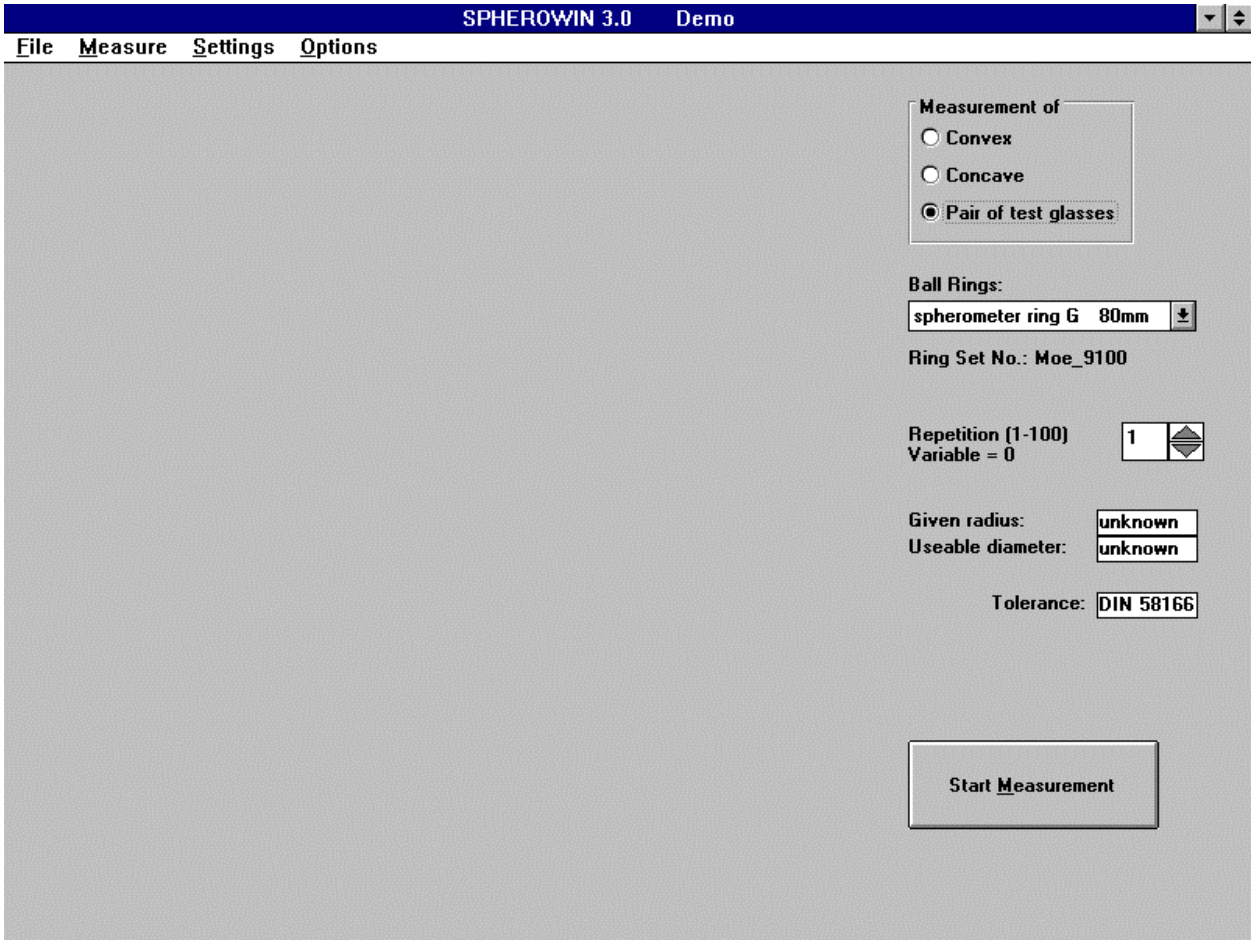

Abb. 5.2: Menu window of the programm

On the right hand side of the menu window are the most important settings and options. This allows a quick overview and facilitates any desired change of the settings and options selected.
These settings may also be modified by clicking on certain text fields, scrollbars etc.

Possible settings using the menu **‘File’**:

- Basic settings save as: The current settings will be saved in file with an extension ‘.kon’ . In this way a library of the basic settings for the different types of the test objects can be maintained.
- Open basic settings: Previously stored basic settings for certainmeasurements are retrieved from the file directory.

- Print protocol file: Protocol will be displayed and Windows standard window prompts for print parameters.
- Stat-file save as: Entering path and file name, under which the values are to be saved for the next statistical processing. These are readings and calculated values, which are of statistical interest. If option "Storing statistical data" is chosen, the data will be automatically stored in the chosen file when the measurement series is completed. This is a text file, each row corresponding to one measurement series, and can easily be converted to a spread-sheet layout for further manipulation of data.
- Prevent setting's change: This option prevents any unauthorised modification of the measurement settings by an inexperienced user.
- If this menu option is chosen, user cannot change the settings of the measurement program.
- Close: Close the measurement program and return to Windows.

Menu **‘Measure’** starts the measuring process.

Measurement my also be started by clicking on the "Start measurement" button.

Possible settings by means of the menu **‘Settings’**:

- Number of measurements: The user has the possibility of entering a desired number of measurement repititions. By entering "0", the number is considered variable and the user determines when the measurement process is completed.
- Permanent measuring: If this menu option is chosen, the number of repititions is variable and the user determines when the measurement process is completed.
- convex / concave / test glasse pair: According to the choice of on of these three options, certain parameters and protocol inscriptions are set.
- Ball rings / Sharp edge rings: Chose according to the type of ring to be used.
- Selection of rings: Selection of the ring diameter.
- Interface: Selection of the plugged in interfaces.
- Measuring device: It is possible to enter the type of the measuring device or other information to be included in the protocol.

Possible settings using the menu **‘Options’**:

- Values in stat-file: If this menu option is chosen, statistical values will be automatically stored in the menu specified stat-file.
- cut off max. and min. values: This option cuases the measurements with the maximum and minimum rise h of the plunger to be automatically rmoved for a measuring series with five or more measuring procedures. These measured values will be ignored in the calculation of the radius, measurement accuracy, etc..
- Radius of test object: User can enter the expected value of the measured radius. This information will be used only in connection with the menu option 'Useful diameter' to calculate the authorised rise h of the plunger, which will be used by the declaration of the radius deviation according to DIN 3140/3 (German Industrial Norm) and by the calculation of the interference rings (reference wave length = 546 nm).
- Useful diameter: Authorised rise h of the plunger can be calculated and compared with the actual one in connection with the menu option 'Radius of test object'. Number of the interference rings, which appear by putting the test object on the test glass, can be calculated knowing this difference and the useful diameter of the test object.
- Tolerance: User has a possibility to enter the tolerance, according to DIN 58166 or self-defined relative and absolute tolerances.
- Save settings at the end: This option causes the last settings to be saved when the program is closed and automatically loaded the next time the program is started.

General Hints to the SPHEROWIN Software

After the start of the measurement follow the instructions of the program; measured values will be displayed after each measuring procedure.
When the desired number of the measurements has been completed, the protocol is displayed and the user is asked, if the Protocal is to be printed and saved. When the measurement series consists of more than 10 measuring procedures, these values will be not displayed on the screen due to lack of space, but they will be included in the printed protocol.

Measuring protocol

Type of ring: Spherometer ring G 80mm
Test object: convex test object
Rated radius: 65
Useful diameter: 89

Measurements:

	plane	convex	plane	convex
1	00,0000	13,0000		

Averaged values of 1 measurement

plane = 0,0000
convex = 13,0000
height difference = 13,000

Calculated radius: **convex radius = 65,0348 mm**

Measurement uncertainty (without uncertainty of contacting) of the radius is: 0,007mm, this equals 0,02%

The radius, according to DIN 58166, is into the range of tolerance. Tolerance = 0,06%
Height difference, related to the diameter, is 0,0129mm,
this equals 47,4 rings (related wavelength = 546nm)

Fig. 5.3: Example of the protocol

6 Installation and Environmental Conditions

The Spherometer should be installed on a stabile horizontal surface in a location with a constant temperature.
The reference temperature für precison measurement is 20° C.
Vibrations, fluctuation in temperature, high humidity and strong magnetic fields should be avoided. All cable and cords should be layed in such a way as to avoid accidents.

7 Technical Data

Range of Measurement:

- Range of linear measurement system: ±30 mm
  Radius R = + 3,2 mm to infinity, Radius R = - 6 mm to infinity

dependant on the spherometer ring, other ranges on request

- Diameter of the object 6 mm to 500 mm

dependant on the spherometer ring, other ranges on request

Measurement uncertainty:

(with statistical probability P = 95%)
Incremental linear measuring system:

- Resolution 0,1 µm
- Accuracy with compensation ± 0,3 µm
  without compensation ± 0,5 µm
- Repeatability accuracy of radius Measurement to ca. 0.001%
- Absolute radius measuring uncertainty (P=95%) with our ball ring component to 0.01%

dependant on the ratio of diameter of the lens to its radius

Reference temperature: 20° ± 0.5°;
Storing temperature: -20°...+ 60°;
Humidity: Jears average: $F_{rel} < 75\%$; maximum: $F_{rel,\ max} < 90\%$.

Dimensions:
LxBxH: 140x140x280 mm³

Weight: 3.5 kg

8 Maintenance und Service

The Spherometer Spheromatic H requires no specific maintenance as long as it is operated in a clean environment.
Varnished surfices may be cleaned with a moist cloth and mild detergent.
The referance surfaces should be oiled with an acid-free Vaseline after use. The Vaseline must be removed with Benzin before use.
The Spherometer Spheromatic H and the Spherometer rings should be sent to the manufacturer regularly for inspection. The frequency of the inspection is dependent on usage, but should be at least once every 2 years.

9 Conditions of Guarantee

Do not attempt to open the Spherometer or to loosen any of the screws. Certain parts are precisely adjusted and secured. By loosining the screws, the adjustment may be alterred and the operation can no longer be guaranteed. In this case, Fa. HOFBAUER accepts no liability and the guarantee becomes void.
In case of any disfunctioning of the Spherometer, the Fa. Hofbauer should be notified.